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# A Kinetic Study on Ground Reaction Forces in Landing Conditions after Spiking in Volleyball

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**Abstract**

**Background:** The purpose of the study was to compare the ground reaction forces parameters in normal and long landing conditions after spiking in volleyball.

**Methods:** 10 male university right-handed volleyball players under "Normal" and "Long" jumping distance conditions of landing after a spike. A standard force plate was used to measure the ground reaction forces.

**Results:** The results revealed that the ground reaction force parameters, the vertical and resultant peak force, vertical and resultant mean loading rates were higher and significant in long landing condition in comparison to normal landing conditions.

**Key words:** Ground Reaction Forces, Landing Conditions, Spiking, volleyball.

## INTRODUCTION

As we look at sports in the 20th century, we see a slow progression of the merging of the athletic fields. This merging is taking place on several plains with mixed results on each one. In the technological perspectives, we have over the last 40 or so years developed the science of training methods which are allowing the athletes to compete at higher levels, give better performances, and allow the athlete to compete longer. These methods include everything from how they perform skills and techniques and how they play.The sport of volleyball has continued to increase in participation since its inception over one hundred years ago. Volleyball has become one of the most widely played participant sports in the world with over 200 million players (Aagaard et al., 1997; Briner and Kacmar, 1997). Successful participation in the sport requires expertise in many physical skills and performance is often dependent on an individual's ability to propel themselves into the air during both offensive and defensive maneuvers. These movements include the jump serve, spike, and block. During the execution of a jump serve or a spike, the player jumps high into the air and strikes the ball at the highest point of their jump in an effort to propel the ball rapidly down towards the opposing side of the net. Defensively, front row players defend against spikes by jumping into the air with their hands raised in an effort to impede the offensive attack. Unlike offensive jumps, defensive jumps are not maximal vertical jump efforts.
The landing in volleyball occurs mainly after spiking, blocking, and jump serving, actions necessary for playing at a high level. Nonetheless, landing is often damaging to olleyballplayers. Briner and Kacmar (1997) found that patellar tendinopathy, known as "jumper's knee", was the most frequent overuse injury in volleyball.To date, there is little information on landing in volleyball. Most previous studies on landing investigated the effects of the height of dropping, although Dufek et al. (1993) showed that the vertical ground reaction force also increased directly with distance from landing and joint stiffness, implying that horizontal distance and

landing techniques are important factors. Furthermore, Masumura et al. (2008) reported that horizontal velocities of the centre of gravity of the body at the toe-off for back row (pipe) spikes in some individuals were three times greater than those for normal front spikes during official games, which raises the question of how a greater horizontal velocity of the center of gravity may affect the ground reaction forces during landing after spiking. The purpose of the study was to compare the ground reaction forces parameters in normal and long landing conditions after spiking in volleyball.

## METHODS

### Participants

Ten male volleyball players (age 18-28 years) from Visva-Bharati University participated in the study. They were the current intervarsity volley ball players who represent Visva-Bharati in the year, 2013, and all of them were right-handed. The purpose of the study and experimental procedures were explained to the participants before testing.

### Experimental trials

The participants were asked to perform "land and stop" type landings on a force platform so that ground reaction forces could be collected for two landing conditions: "Normal" and "Long" jumping distance landing after spike. In the Normal condition, a volleyball was tossed to the setter as if it were a pass from the centre of the court. Then, the setter set the ball to the hitter's position for a spiker to jump, and hit before landing on a force platform. In the Long condition, participants spiked a ball taking off from a spot 0.7m further away than that in the Normal condition to simulate landings with an elongated jumping and large horizontal velocity. An additional tape marker on the floor was used to set up the farther take-off point from which the participants should jump. The 0.7-m increase in jumping distance was based on a preliminary experiment. For both conditions, the participants were asked to perform all trials with maximal effort to simulate match-play. Successful trials were "land and stop" landings in which the player landed on both feet at almost the same time remaining on the force platform and the complete spike sequence conformed to the rules of volleyball. One successful trial for each participant under each condition was selected for further analysis.

### Data collection

The participants were given sufficient time to perform stretching and warm-up exercises before data collection. When they felt ready, after some rehearsal, data collection was performed in the order of Normal and Long conditions. The number of attempts was 3 for each successful trial. The best evaluated trials were selected for further analysis. The ground reaction forces were obtained with a power timer force platform embedded in the floor. The data were captured simultaneously, and stored on a personal Laptop.

### Statistical Analysis

A paired t-test was conducted for each individual dependent variable to assess the differences between the two conditions. All statistical testing was carried out using the Statistical Package for Social Sciences (SPSS V16.0).

## RESULT & DISCUSSION

The paired comparisons of the Ground Reaction forces Parameters in Normal landing and long landing conditions after a spike in volleyball are presented in Table-IV

**Table-IV: Paired Comparisons of the Ground Reaction Forces Parameters in Normal Landing and Long Landing Conditions N=10**

| Parameter | Landing Condition | |
|---|---|---|
| | Normal | Long |
| **Peak force (N/kg)** | | |
| Vertical* | 88.61±21.32 | 108.57±20.43 |
| Horizontal | 20.95±2.49 | 25.71±6.70 |
| **Time (s)** | | |
| Vertical peak force* | 0.04±0.006 | 0.03±0.007 |
| Horizontal peak force | 0.02±.014 | 0.021±0.006 |
| **Mean loading rate (N/kg/s)** | | |
| Vertical* | 2168.14±799.63 | 3729.83±989.70 |
| Horizontal | 1089.04±478.59 | 1509.16±912.52 |
| **Maximal instantaneous loading rate (kN/kg/s)*** | 829.46±318.03 | 1198.44±308.46 |

***** Significantly different at **P < 0.05.**

The result of the above table clearly shows that the ground reaction force parameters, the vertical and resultant peak force, vertical and resultant mean loading rates were higher and significant in long landing condition in comparison to normal landing conditions. In case of maximal instances loading rates were significantly different in normal and long loading conditions.

In the present study it was found that in the ground reaction force parameters it was found that vertical peak force was significantly different and higher in long landing condition because of greater force applications in vertical as well as horizontal components. The maximal instances loading rate was significantly different. The ground reactions force data was obtained using the force platform of power time tester for landing on both legs. The results also show that the legs were loaded with high amount of in a very short durations, which may be dangerous to players and leg injuries may occur. The landing after a spike in matter of high concern because 45% of injuries in volleyball occurs due to this (Tillman et.al; 2004). The vertical peak forces were four times higher than the horizontal peak forces. Due to higher resultant ground reactions forces of every landing, it was found that in most of the landing the centre of pressure was located closer to the left foot.

## CONCLUSIONS

Based on the analysis and within the limitations of the present study, the following conclusion were drawn:

Horizontal and vertical velocities in spiking with long jumping spike when compared with normal spiking, leading to several postural changes at initial contact and at the same time increased peak ground reaction forces and mean loading rates.

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